A QUARTERLY JOURNAL OF METHODS AND INFORMATION FOR TEACHERS OF SCIENCE

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The SCIENCE COUNSELOR

Volume XXI ★ Number 2 ★ June 1958

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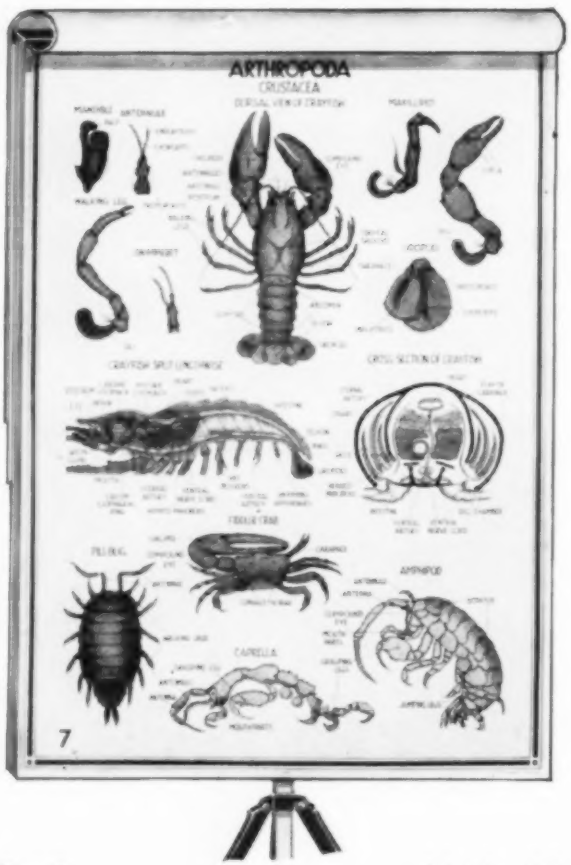

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The Science Counselor

"FOR BETTER SCIENCE TEACHING"

A QUARTERLY JOURNAL *of teaching methods and scientific information especially for teachers of science in Catholic schools. Indexed in the Catholic Periodical Index. Published at Duquesne University, Pittsburgh, Pennsylvania, in March, June, September and December by*

DUQUESNE UNIVERSITY

Subscription Price: $2.00 per year; Canada, $2.25. Single copies of issues in the current year, 60¢ each.
Business and Editorial Offices at Duquesne University, 901 Vickroy Street, Pittsburgh 19, Pa.

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An Ancient Metal—Lead

By James A. McCulloch, Associate Professor of Classics, Duquesne University, Pittsburgh 19, Pa.

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Ion Exchange Resins in Industry, Science, and the Home

By H. E. Weaver, Rohm & Haas Company, Washington Square, Philadelphia 5, Pa.

Television Teaching Of Organic Chemistry

• By **Kurt C. Schreiber, Ph.D.,** *(Columbia University)*
HEAD, DEPARTMENT OF CHEMISTRY, DUQUESNE UNIVERSITY

The use of television to replace the "live" teacher has been the subject of much study and experimentation.

Organic chemistry presents several special problems in television, and for this reason it was made the subject of an experimental study.

●

During the academic year 1956-57 Duquesne University conducted an experiment in teaching Organic Chemistry by closed-circuit television. The choice of subject was not arbitrary. Organic Chemistry, perhaps like no other subject, normally depends on the continuous use of the blackboard throughout the lecture period. The test, therefore, was whether the restricted use of the blackboard would make it impossible to present this subject over TV and what techniques could be devised to minimize the use of the blackboard. Since this represented Duquesne's first experiment in TV-teaching, we were also concerned with the question of the student-teacher relationship and the performance of the students.

In establishing our basis for evaluation and comparison of the outcomes of this course, we divided the students enrolled into two groups. The first group, hereafter referred to as the "live" group, was present in the studio with the instructor. The second group, hereafter referred to as the "receiving" group, was in a separate room and received their instruction by means of a twenty-four inch television receiver. The "receiving" group was provided contact with the instructor by means of a two-way intercom system, and thus could maintain vocal contact with the instructor at all times throughout the duration of the classes.

Since the total number of students enrolled in this course was only fifty-one, we realize that this is too small a group to represent an accurate statistical sample. However, it is interesting to note that our results, like the results of so many experiments in TV teaching of other subjects in the past five years, show that the acquisition of the knowledge of organic chemistry was in no way impaired through television teaching.

The Blackboard

Let us now consider the problem of the blackboard. The total blackboard area available in a large lecture room cannot be reproduced on the TV screen keeping the writing readable. This means that only a small portion of the board can normally be seen on the screen, which is not serious when a relatively small amount of writing is presented during the lecture, as in many subjects previously tested for TV-teaching, but when the teacher writes continuously, the only way television can keep up is by moving the camera with the teacher as he writes. This presents a definite strain on the student who is a slow writer. While in the regular lecture course he can fall behind and still continue to copy from the blackboard even though the teacher has gone on to other reactions, in television receiving he must be able to copy as fast as the material appears on the screen. Some students, for this very reason, find that they concentrate more in TV receiving than normally, but others find the pace too fast for them.

To minimize the use of the blackboard, four to six charts were prepared prior to each lecture. The charts (28 inches by 22 inches) were made by writing with black ink (one inch lettering) on light-grey cardboard. The length of time spent in going over these charts varied from four to ten minutes. On many occasions the discussion of the material on the chart was interrupted by supplementary equations put on the blackboard. The material on these charts was given to the students on mimeographed sheets containing between 5 to 7 equations per page with enough space between the equations for the student to write additional comments. It might be said that this represented a "prepared notebook." This technique helps to eliminate the complaint of students, even in conventionally taught organic chemistry courses, that they have a tough task to copy all the material from the blackboard and at the same time take notes on the comments made by the instructor concerning these equations. Even though this helped considerably in the presentation, the restriction on space was severely felt by the instructor particularly during the last few weeks when the more complex organic compounds were discussed.

Demonstrations

During the last few years lecture demonstrations have been introduced into the lectures in organic chemistry at Duquesne University. This has been done in order to decrease the number of test-tube experiments in the laboratory and, therefore, enable an increase in the synthetic ones. Also it makes it possible to tie these experiments closely to the lecture material and to develop the technique of careful observation and analysis of the experiment.

As might have been anticipated this phase of the course was particularly satisfactory over television. Minute observations (such as the exact location of the thermometer bulb in a distillation set up) could readily be made on the TV screen while in a large lecture room the students could hardly be expected to see such small details. The lack of color made it necessary to omit some experiments. However, since organic chemistry is a course for sophomores and juniors, colors could be readily described in terms of chemicals with which the student should already be familiar.

(Continued on Page 46)

The Harvest of Fragrance . . . SANDALWOOD

• **By Noel Owers, Ph.D.,** *(Nagpur University, India)*
DEPARTMENT OF BIOLOGY, DUQUESNE UNIVERSITY, PITTSBURGH, PENNSYLVANIA

Among the world's many valuable woods, sandalwood is one of the most precious. The exotic fragrance of the wood and of the extracted oil has been an olfactory ambrosia that has attracted the attention of mankind from very early times. Its long standing use in eastern rituals and more recently in the cosmetic industry has created an enduring and ever increasing demand.

●

Early Origins of the Sandalwood Trade

Sandalwood trees (Figure II) appear to be indigenous to a narrow zone near the equator composed of a series of islands beginning from entrancing Bali and Timor near eastern Java and ending in the paradisiacal Hawaiian Islands in the Pacific Ocean. The early Hindu religious books in India contain references to a fragrant wood called *chandana*, the sanskrit name now applied exclusively to *Santalum album* (true sandalwood) belonging to the family Santalaceae, but this may have been *Pterocarpus indicus* of the family Leguminosae which is native to South India and which like *Santalum album* has a somewhat sweet smelling wood. It was probably the latter that was imported by Solomon in the 10th century B.C. for building the temple in Jerusalem. But it also might have been one of several other kinds of odoriferous woods that have been offered as substitutes for sandalwood from time to time. More authentic reports give the 6th century for the earliest introduction of sandalwood to the Middle East. The use of sandalwood was certainly known to the Chinese Buddhist priests who used it for their temple rituals, calling it *chan t'an* and later *t'an ksiang*, the *t'an* fragrance. Small quantities of the wood were known to have been imported from the Hawaiian Islands into China during the period 1790-1810.

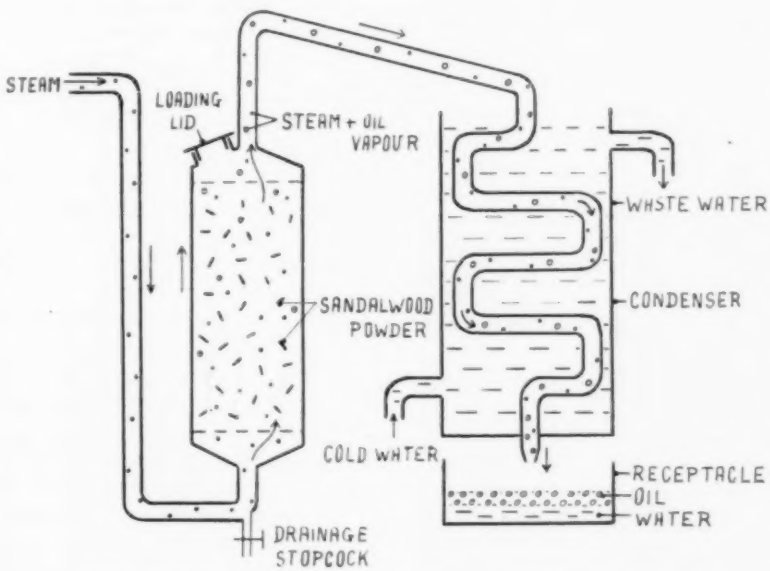

DIAGRAM SHOWING METHOD OF DISTILLATION OF OIL FROM WOOD
FIGURE I

Although Blundevil in 1594 records, ". . . from the ile of Timor doth come . . . the white and pale medicinable sample called Sandalum," it was but comparatively recently that trees of this kind were discovered in the Pacific Islands by sea-faring adventurers from European countries. When they burnt the trees as firewood, they were amazed by its fragrance. The wood was then evidently taken back to Europe where its discovery created considerable stir. Ship after ship set forth from Europe to gain possession of the rare and valuable wood. A sort of "sandalwood rush" not unlike the famous Klondike Gold Rush followed. The insufficient and diminishing supply of white sandalwood gave it an increasingly high value. Hence trade in the wood was profitable even despite the long haul involved.

The Royal Debt

The sharp upward trend in the sandalwood trade evidently began in 1809 when two brothers, Captains Jonathan Winship and Nathan Winship, together with William Heath Davis sailed on an American ship from Honolulu to Canton with a full load of sandalwood which they sold at a considerable profit. The sandalwood tree or *ilialu* or *lauhala* (lau, wood, hala, sweet) as it was known to the Hawaiians, was a boon which at first brought prosperity to the islands. But it also carried with it seeds of disaster. The king Kamehameha I, granted the trio of Americans a monopoly which he later cancelled and took over for himself after he found how lucrative the business could be. About $400,000 worth of sandalwood was exported per annum and it thus became the first and most important article of commerce of the Hawaiian Islands. The king bought the white man's sailing ships and paid for them in equal to double their weight in sandalwood. The kings Liholiho and Kamkeaouli paid the equivalent of $77,000 for a brig and its

cargo, $800 for a looking glass and $10,000 for a brass cannon, all paid for in sandalwood. Other reckless purchases, given on credit for sandalwood to be delivered later, increased the royal debt which in 1821 amounted to $200,000. Sandalwood became the article of barter on the islands in the absence of local coinage.

FIGURE II — SANDALWOOD TREE. These trees have no true root system, but attach themselves by haustoria (sucking roots) to the roots of other plants.

As the desires of the king for western manufactured goods increased, the royal debt grew ever greater. A demand for more and more frequent taxes in sandalwood resulted, and the people were ordered to search and cut all trees into logs 6 to 8 feet long, which brought the highest price. The easily accessible sandalwood stands had already been felled and so the people had to climb farther into the wet and cold mountains where many died of exposure. While they were away in the interior, crops were neglected so that famine came to the islands and took its toll of the king's subjects. Under these conditions trees were felled recklessly. Little effort was made to preserve young trees or to replace those which had been cut down. Cattle grazing, forest fires and lumbering for firewood added to the rapid removal and in a few years, sandalwood trees had all but disappeared from the islands. In 1831 the wood gathered was so small in quantity and so inferior in quality that its value fell sharply and this poor yield ended the sandalwood trade in the Hawaiian Islands.

$800 a Ton

The family Santalaceae comprises 26 genera and 250 species of which 19 species of *Santalum* occurring naturally from Java to Juan Fernandez, Hawaii, have been recorded. The most important single source of sandalwood today is South India. But even this is not sufficient to meet demands, and nowadays India supplements its native supplies by importing quantities of *Santalum spicatum* and *S. acuminatum* from Singapore which in turn imports from Australia where sandalwood silviculture has been more recently developed.

In Mysore State alone, a part of South India, the annual yield is about 2500 to 3000 tons. A ton of wood costs nearly $800. It is interesting to note that both in Mysore and in the adjoining State of Kerala the sandalwood industry is traditionally the exclusive monopoly of the State. Historical records indicate that the British East India Company recognized this monopoly in one of its many treaties with the Mysore kingdom back in the early 19th century.

Indian Wood & German Oil

Until 1916, Germany was the only country which distilled sandalwood oil on a scientific basis from wood supplied from India. But World War I (1914-1918) cut off the Indian imports and the Germans were left with no option but to shut down their sandalwood oil distilleries.

When the German market closed, the Government of Mysore decided to operate a local distilling plant. In 1916 a factory run on modern lines was started. During the few decades since its inception, this factory has distilled all the oil marketed by Mysore State. Kerala State also operates a distillery utilizing the sandalwood produced in the state-owned forests.

Sandalwood Is a Parasite

Sandalwood grows wild in most districts of Mysore and Kerala. Trees attain maturity after about 10 years, when they are suitable for distillation of oil. Species of Santalum, and indeed other members of Santalaceae, are among those curious plants which cannot feed themselves. They have no true root system, but attach themselves by haustoria (sucking roots) to the roots of other plants, tapping their sapstream for nutrient solutions. They appear to be very catholic in their choice of hosts, being able to grow on any one of 160 species of flowering plants (Angiosperms) belonging to many different families.

FIGURE III — Sandalwood Hand Carving.

A wild South Indian shrub, *Lantana*, generally considered an agricultural pest, redeems itself by helping in the growth of sandalwood seedlings. The *Lantana* serves as a "nurse" permitting the sandalwood seedlings planted in their midst to suck nourishment from their roots and grow into mature trees. When cultivated under the unnatural conditions of a seedsman's nursery the seedlings will germinate. However, unless other plants are near enough for the haustoria of the seedlings to develop on their roots, the seedlings will wither as soon as the food stored in the seeds has been used up. Thus for growth to maturity they must be grown among other plants, either by design under cultivation or by chance in their natural habitat.

The young sandalwood tree has white heartwood in which a minute amount of oil is present. As the tree grows older its oil content increases. Its wood becomes yellowish, then brown and eventually the fully grown tree has a brownish red wood which contains the maximum percentage of oil. Although the tree matures in a decade it is very slow growing and even after the proverbial four score and ten years the height of a tree will seldom exceed 30 feet and the diameter 20 inches.

True & False

Merchants generally distinguish three kinds of sandalwood according to colour. White sandalwood is obtained from *Santalum album*, a tree resembling myrtle, found on the Malabar coast (India). Citron or yellow sandalwood is from *Santalum freycinetianum*, found in the South Sea islands. Red sandalwood is the deep red heartwood from *Pterocarpus santalinus* L. from which a red dye is extracted known to Indians as *rukla chundan*. Other species of wood have been mistakenly called sandalwood, but resemble the genuine sweet-scented, close-grained wood of *S. album* in texture only but not in odor. These are *Bucida capitata* (West Indies), *Eremophila mitchelli* (bastard sandalwood), *Eremophila sturtii* (scentless sandalwood), *Alyxia buxifolia* called the native sandalwood in Tasmania, and *Quercus abelicea*, the false sandalwood of Crete. Some unscrupulous dealers quite commonly impregnate the surface of an inferior wood with sandalwood oil and sell it as sandalwood.

Stages In Production

As soon as sandalwood trees attain a stage suitable for the distillation of the oil, they are felled and the sapwood and outer bark is stripped off with the aid of hatchets. In earlier days the logs would be allowed to lie in the forest and the outer useless layers of sapwood would either rot or be eaten by termites. But this takes more time than the present-day mechanical process of hewing off the unwanted portions. The heartwood is taken to storage depots situated in various parts of the forest. Here, the wood is sawn into billets which are put together in small piles. Next comes the selection. The best part of the wood of each tree is retained for carving, while the remainder is sent to the distillery. In the distillation factory, the billets are chipped into small pieces and then ground into fine powder. At this point the wood is ready for distillation of its oil content.

The distillation chambers are huge cylindrical vessels with two openings, one for letting in and another for letting out steam (Figure I). The sandalwood powder is then shovelled into these vessels and steam let into them at high pressure. The steam, as it passes through the stills, carries along with it the vapour of the oil that is in the wood. The vapour-laden steam is then cooled in large condensers, where the vapour condenses to form oil. Since the sandalwood oil is lighter than water it floats on the surface. The oil is then withdrawn, purified by various chemical processes, packed in bottles of various sizes and is ready to be sold on the market.

Gudigars — The Sandal Carvers

Sandalwood oil is sold all over the world to drug companies and to perfumery and soap industries.

Sandalwood powder goes into the making of incense and joss sticks that are used daily in homes, temples, mosques and pagodas throughout India, and the Middle and Far East. The wood is also used for making costly

FIGURE IV — Sandalwood Hand Carving.

FIGURE V — Sandalwood Hand Carving.

furniture, delicate sculptured articles, and highly intricate turnery. From the earliest times, Indian artists have been famous for their carvings made from sandalwood (Figure III). Members of a community known as *gudigars* specialize in the art of carving, and the skill has been passing from father to son for many generations. These people live mainly in the towns of Sagar and Sorab in west Mysore State. Encouraged by the Indian Government, their handicraft is now an important cottage industry and sandalwood carvings form an important part of India's cultural heritage.

In the Orient, particularly in China, Burma and India, the wood is used for making idols and sacred utensils for shrines, and as a fuel for funeral pyres of the rich. The distilled oil is used in numerous medicines, perfumes, and cosmetics and as a body rub. In India the oil mixed with paste, is used by Brahmins for caste markings.

At one time even the thick oil pressed from the seeds of sandalwood trees served as illuminating oil. In 1599 Fitch in Hakluyts Voyage records that ". . . the white sandol is wood very sweet . . . the Indians grinde it with a little water and annoynt their bodies therewith." The Persian kings, in their heyday, imported ships full of sandalwood. Parke in 1588 in a translation of Mendoza's History of China, records that, ". . . when the king doth die, they do . . . burne his bodie with wood of Sandalo." But with the sad passing away of institutional monarchy in Persia and other eastern nations, sandalwood has found better use as the carver's symbol of Man's creative art—and its fragrant oil seems just a whiff from Paradise beyond. ●

BIBLIOGRAPHY

Chattaway, M. M. 1952. "With a cargo of ivory . . . Sandalwood . . . and sweet white wine," The Victorian Naturalist. Vol. 68, No. 10.

Harold, St. John. 1947. The history, present distribution and abundance of sandalwood on Oahu Hawaiian Islands. Hawaiian plant studies. #14. Pacific Scientist. I (1) : 5-20.

Iyengar, G. Srinivasa. 1937. Life history of *Santalum album L.* Jour. Ind. Bot. Soc. Vol. XVI, No. 4. p. 175.

Jane, F. W. 1956. The structure of wood. New York. MacMillan.

Murray, Sir James A. H. 1914. A New English Dictionary. Oxford. Clarendon Press. Vol. VIII-Q-SH. Part II S-SH.

R. L. 1957. The Fragrant Harvest. Article in newspaper 'Yogana.' Edited by K. Singh. Vol. I. No. 13. New Delhi.

Sreenivasaya, M. 1948. The Spike Disease of Sandal. Current Science. No. 5. May pp. 141-145.

Television Teaching

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Questions from Students

In the chemistry lectures at Duquesne University the students have had the opportunity to interrupt freely for questions. This procedure was continued for the "live" group. The "receiving" group was able to ask questions via the intercom system mentioned above. Even though the students were frequently urged to make more frequent use of the opportunity to ask questions, it was noted that *both* groups were more reluctant to ask questions than normally. On direct question the students indicated that they were loath to interrupt since the TV lecture was such a complicated "production." This problem will disappear as the students will become more accustomed to this new medium of education.

It has been my practice in all my lectures to establish contact with the students by asking questions of them during the lecture. With the use of the intercom system it was possible to continue this procedure, and to draw the student in the receiving room closer to the teacher. He, too, was part of the lecture and not merely a passive receiver on the other end.

During the second semester the following system was tried to give a closer student-teacher relationship. The two groups were rotated at regular intervals, thus giving all the students a chance to attend class face to face with the teacher and also to give the teacher a chance to become acquainted with the members of his class. It is the opinion of the writer that a three-week rotation system would work satisfactorily.

Student Reactions

During the experiment, we tried to obtain the opinions of the students by a series of three questionnaires. While I do not want to describe the questionnaires and their results in detail here, I would like to mention a few highlights. One question was "Do you feel that you could learn as much through television classes as you could in conventionally taught classes with the same teacher?" At the start of the semester 9 indicated that they would learn more, 10 about the same and 31 indicated less. At the end of the semester 9 indicated more, 25 about the same and 15 less. At the end of the semester the members of the "receiving" group were asked "If you were to participate in another class of this type would you prefer to be in the 'live' or 'receiving' group?" 12 preferred to be in the "live" while 13 preferred to remain in the "receiving."

It should be mentioned that close cooperation between three departments of the University, namely Chemistry, Journalism and the Testing Bureau, was necessary for the successful completion of this project. This interdepartmental effort unintentionally served to bring about a better understanding of each others problems.

A great deal more experimentation with the use of TV in education is necessary. It is not the answer to all the problems of our educational system, but like other teaching methods it has its proper place. ●

Martian Atmosphere Restudied

• *From: The U. S. Department of Commerce*
NATIONAL BUREAU OF STANDARDS, WASHINGTON, D. C.

Telescopic observations strongly suggest that Mars has an atmosphere similar to, though more transparent than, the atmosphere of the earth. For more specific information on the Martian atmosphere, astronomers have relied mainly on the spectroscope or spectrograph, instruments that analyze the sunlight reflected from the planet's surface. In principle, the gases present should reveal themselves by their characteristic absorption lines and bands, but results so far have not been conclusive. However, the persistence of inconclusive results despite increasing sensitivity of observing techniques has led to lower estimates of the quantities of gases, such as oxygen, water vapor, and carbon dioxide, that may be present on Mars.

Another attack on this problem has been made by scientists of the National Bureau of Standards, and they have now completed analysis of the spectrograms obtained during the close approach of Mars in the late summer of 1956[1]. Two husband-and-wife teams—C. C. Kiess, H. K. Kiess, C. H. Corliss, and E. L. R. Corliss—participated in the investigation which was sponsored jointly by the National Geographic Society and the National Bureau of Standards.

Using more sensitive instruments than have been previously applied to this purpose, the scientists photographed the Martian spectrum under the excellent observing conditions at the new high-altitude observatory, operated by the U. S. Weather Bureau on Mauna Loa volcano in Hawaii. Also, in an effort to extend observations farther into the infrared, another set of spectrograms was made at the Georgetown College Observatory in Washington, D. C.

The investigation concentrated mainly on a search for oxygen and water vapor. The results indicate that both of these, if present, occur in quantities too small to be detected with the equipment used. On the basis of laboratory tests of spectrograph sensitivity to water vapor, this means that there is less H_2O in the Martian atmosphere than there is in a film of water 0.08 mm (1/300 in.) thick. The spectrograms also showed no trace of the carbon-dioxide lines that have been observed in Venus, or of spectral lines of the noble gases.

It is believed that these results are not incompatible with the presence of water vapor in amounts sufficient to explain, for example, the transport of water from one polar cap to the other. For it is now fairly well established that the white polar caps of Mars consist of solidified H_2O, and it is reasonable to suppose that the seasonal process in which one cap shrinks while the other expands is due to the transfer of water vapor over the Martian surface.

The results do raise the question, however, as to whether the spectroscopic tests hitherto used are delicate enough for the purpose. In the case of H_2O molecules, there is reason to believe that the bands that have been used (because of accessibility to present methods of observing) are not the most sensitive ones. Both theory and experiment indicate that much stronger bands occur farther in the infrared, but different or improved techniques are needed to detect them on Mars. The use of spectrographs mounted in high-altitude balloons, rockets, or artificial satellites will reduce the difficulty further.

Methods

The light from Mars, as received near the earth's surface, is really a composite of 3 different spectra. Specifically, it contains absorption lines originating (1) in the reversing layer of the sun's atmosphere, (2) in the atmosphere of Mars, and (3) in the atmosphere of the earth. The wavelengths of the solar lines are accurately known and so can be easily identified. For the much more difficult task of distinguishing lines due to Mars from those due to the earth, 2 methods have been in use.

One method is to observe Mars at "opposition," that is, when Mars, earth, and sun are most nearly in a straight line, with the earth between the other two. Its distance from the earth being a minimum (or nearly so), Mars is then at its brightest. Also, because the distance between Mars and the earth is neither increasing nor decreasing, absorption lines originating in the atmosphere of Mars will not be separated by Doppler shift from those originating in the earth's atmosphere; so that oxygen lines, for example, from Mars will be superimposed on those from the earth. In such a case, the line may be noticeably intensified or, more likely, distorted; that is, since the Doppler shift is not negligibly small except for a brief interval, the intensity profile of such a line, as measured with a microphotometer, would be asymmetrical. Such distortions might be detected more readily by comparison with corresponding lines in the spectrum of the moon (which has no atmosphere of its own).

The second method is to observe Mars at some time before or after opposition, when the Doppler shift would separate clearly the Martian from the terrestrial lines. Then, if there is oxygen in the atmosphere of Mars, one might expect the oxygen lines caused by the earth's atmosphere to have faint companions separated by the amount of the Doppler shift.

Comparison with the spectrum of the moon, obtained under similar conditions, would allow the Doppler shift to be measured—for example, by the relative displacement of the solar lines. Comparing the Martian spectrum with the more familiar spectrum of the moon would also help in detecting any unknown lines that might show up.

The second method was used in the present investigation. Spectrograms were obtained about 7 weeks before opposition at Mauna Loa and about 6 weeks after opposition at the Georgetown observatory. In the earlier spectrograms the Doppler shift was 0.22 Å (angstroms) towards the short wavelengths, and in the later ones 0.25 Å towards the longer wavelengths. The measured values of the shift agreed well with the values calculated from the orbital velocities of Mars and the earth.

Instruments

The new study of the Martian spectrum was undertaken in order to see what could be done with the newer aids to observation. These include better diffraction gratings and optical systems, faster photographic plates, and more accurate guiding mechanisms for prolonged photographic exposures.

Before proceeding to Hawaii, the scientists tested the feasibility of using high-dispersion concave gratings for planetary spectroscopy at the Georgetown observatory. Various arrangements were tried out on Jupiter, which was then about as bright as Mars would be in July 1956. The tests justified proceeding with the project and showed that the mounting devised by Wadsworth would be suitable for the grating.

Light is gathered from Mars with a siderostat, a mirror that is motor-driven (with manual fine adjustment) so that the light is always reflected in the same horizontal direction towards the rigidly mounted telescope lens and spectrograph. The telescope lens focusses an image of the planet onto a slit, and the light passing through is converted into a parallel beam by a collimating mirror. The beam then strikes and is reflected from a concave diffraction grating which spreads the light out into its components according to wavelength. The light as thus spread out—i.e., the spectrum—falls upon a thin glass photographic plate which is curved to fit the focal plane of the grating.

Two diffraction gratings were selected. One was ruled by R. W. Wood at Johns Hopkins University and has 15,000 lines per in. and a (reciprocal) dispersion of 5 Å per mm. The other, ruled by H. G. Gale at the University of Chicago, has 30,000 lines per in. and a dispersion of 2Å per mm. Both have the special virtue of concentrating much of the light in one of the first-order spectra. The telescope lens, 12 in. in diameter and 12 ft. in focal length, was made by J. Clacey, former chief optician at the National Bureau of Standards.

Observations

The observatory on Mauna Loa offers many advantages to the astronomer. Situated in the midst of the Pacific at an altitude of 11,134 feet, it is free from the ruggedness of terrain that produces turbulence in the surrounding air. Particularly important is its height of about 1 mile above the inversion layer of the atmosphere. This is the level at which the temperature of the air starts to increase with increasing altitude; the bulk of atmosphereic dust and moisture are trapped below it.

Built for the joint use of the U. S. Weather Bureau and the National Bureau of Standards, the Mauna Loa observatory was only recently put into service[2]. In fact, the scientists making the present study arrived in time for the dedication ceremonies and began the Mars observations immediately afterwards.

Spectra of Mars and the moon were obtained successively on the same plate, the exposures to Mars lasting 3 hours each. The Wood grating was tried first. The spectrograms proved sufficiently dense to warrant using the more dispersive Gale grating, which was then set up to photograph wavelengths from 5800 to 7400 Å.

The Doppler shift is clearly evident in the best spectrograms. In several cases, lines of solar origin that are hidden behind terrestrial lines in spectrograms of direct sunlight are shifted out of their hiding places and appear separately in the spectrum of Mars. If any lines due to water vapor or oxygen in the atmosphere of Mars appeared in the spectrum, they should be shifted by about 0.22 Å from those of terrestrial origin. However, there are no companion lines to be seen with the strong lines either in the Fraunhofer *B* band of O_2 (roughly 6870 to 6940 Å) or in the *a* band of H_2O (roughly 7200 to 7300 Å).

Later, the spectrograph was set up at the Georgetown College Observatory. The aim was to extend observation farther into the infrared than was possible at the time on Mauna Loa. The lower altitude of Washington, D. C. made it necessary to use the Wood grating; exposures to Mars were each about 5 hours long. The portion of the spectrum from 5000 to 9000 Å was photographed and scanned for lines of atomic nitrogen, oxygen, and the noble gases, as well as for the A band of O_2 (about 7600 to 7700 Å), the H_2O band at 8200 Å, and the CO_2 bands at 7820 and 7889 Å that were found (1932) by W. S. Adams and T. Dunham, Jr., in the spectrum of Venus. Again the Doppler shift was clearly evident, but none of the lines sought for could be detected.

Interpretation

The results of this investigation, which extended over a greater wavelength range and utilized higher dispersion than those previously reported, confirm the findings of W. S. Adams and T. Dunham, Jr[3]., in 1934 and 1941, with respect to the low abundance of oxygen and water vapor in the atmosphere of Mars. The numbers of molecules of both gases are too small to be detected with the equipment used.

In the case of water vapor, tests with a spectrograph of dimensions close to those of the one used in this study were made in the Bureau's spectroscopy laboratory. Under conditions in which the water vapor in the light path was equivalent to a water film 0.15 mm thick, a few of the strongest lines of the *a* band and the one at 8200 Å were detectable. Since none of these were detected in the spectrum of Mars, the water-vapor content of its atmosphere must be less than that of a film of water 0.08 mm, or half of 0.15 thick; this

(Continued on Page 66)

An Amateur Plants Fern Spores

• **By Kathryn E. Boydston**
FERNWOOD, ROUTE 3, NILES, MICHIGAN

This back porch adventure with ferns is easily adaptable for use as a class project. The space and equipment required are at a minimum.

This paper was presented at the 1957 A.I.B.S. meeting in California, and was published in the AMERICAN FERN JOURNAL, *Spring 1958.*

The author is a director of the Spore Exchange of The American Fern Society. Those interested in this activity of the American Fern Society can obtain information by writing to Mrs. Boydston.

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For many years, I have been torn between two compulsions—an insatiable interest in ferns and a deep belief in conservation. There is a strong urge in me to see or to have every fern I hear or read about. The more I have, the more I want, whether they are in a connoisseur's catalogue, in a lovely woods, or just beyond a barbed-wire fence! Especially do I crave the smaller rock-loving ferns, and the rarer they are, the more I desire them. My urge to conserve has kept me within bounds, and although I'd never denude a rock of its rare Asplenium or touch a rarer Hartstongue, this does not in the least lessen my wanting them.

The little porch shown in the accompanying picture is smaller than it looks, scarcely 6x8 feet, and was not really planned, but like Topsy, "it just grew", and it might never have come about at all except for my fortunate meeting with our late Treasurer, Mr. Matt Mann, on the Vermont-New York Fern Society field trip in 1952. Mr. Mann claimed to be an amateur, yet he was successfully growing many ferns in a roughly-made propagating box in his basement. His methods were described and his propagator pictured later in the American Fern Journal. As he gathered a few bits of fertile fronds on the trip, or shook spores into an envelope, he generously answered my many questions and added his assurance that if he could do it, I could. He gave me a bit of each kind he gathered and thus opened up a whole new world to me as I realized that perhaps some of these long-wanted, nearly-gone, or extremely rare ferns might someday be grown right here, and this with a help to conservation rather than a hindrance!

Instead of the basement for propagation, I began to think of this small back porch.

An electrician installed the lights just below the top shelf: a double-tube 48" fluorescent light with shade reflector for the center part and a matching 24" double-tube light for each end section. The top of these reflectors was painted light gray. An inexpensive chicken-brooder timer was installed inside the broom closet to turn the lights on and off automatically at the appointed hours of 5:00 A. M. and 11:00 P. M., respectively. We chose an 18-hour light day for no particular reason except that some advice was for 16 hours and some for 20 to 24 hours.

Up to this time, I had intended to use many ivies or scented geraniums or other home plants on the top shelf, but I blame them for an infectation of thrips that later attacked Hartstongue and other tender fern morsels below. Since then, the ferns have taken over and have proved a surprisingly magnetic attraction to all who enter the front door and see them for the first time.

That first fall, I tried planting spores gathered at home and on the 1952 and 1953 Fern Society trips. All the recommended ways were tried. I planted spores of Pellaea atropurpurea and of Asplenium platyneuron in six ways each. On the same day, spores from the same fronds were planted (1) on sterilized soil, (2) on porous brick set in water, (3) on tuffa pieces set in water, (4) on an inverted sphagnum-filled clay flower pot, (5) on pure peat, and (6) on finely-sieved sphagnum. Each was glass-covered. In both species the soil was so far ahead in amount as well as promptness of

THE SMALL FERN ROOM. On the top shelf the larger-sized potted ferns; the middle shelf holds the 5-inch dishes of prothallia; the bottom shelf, the terrarium cases with sporlings planted in rows. Note the fluorescent fixtures under the top shelf.

germination, it has been used in all later work since then.

This first planting was fairly successful, but there was something so untidy about all these glass-covered pots of varying size and condition that it was far from satisfying. Clay pots were banished in favor of glass dishes for planting of spores. These were pyrex, which could be boiled, baked or steamed. A row of them looked very perky on the glass shelves. There were 18 round pyrex dishes 5" in diameter which were on hand and just the right number to fill the long shelf.

It had been my intention to transplant into other pans or pyrex dishes. However, I decided to plant them in rows directly in the soil of a large terrarium-like case. Since at times, the terrarium cases must be glass-covered, there is one glass cover to fit each of the two end cases. The center case has two pieces of such size that there are, all together, four different lengths all the same width and when the glass is to be removed gradually, they can be shifted around to allow more air and open space without shock to the ferns.

By this time, Dr. Benedict had organized the American Fern Society spore exchange and knowing of my enthusiam for this newest venture asked me to receive and distribute them. This was a challenge and an opportunity. As I began to receive them and also to gather more kinds myself, it was soon apparent that more dishes were called for. Twenty-seven dishes were bought for the upper shelves.

As spring was cold and late, the ferns in the lower cases had outgrown their quarters. More elbow room and root room was needed. So three "collars" of heavy aluminum were made to fit the top pan. They were like the sides of a box but with no bottom. This allows 3½" of soil and space for many more rows of plants. They may be used 1, 2, or 3 at a time as need dictates and are easily stored.

Some kind of shade above the lights is needed to protect dishes and plants from the winter sun. In summer there are enough shade trees outside, but when the winter sun does shine through the glass, it has been necessary to shade the dishes with a strip of paper or cheesecloth. I plan now to weave some matchstick push-back shades.

There are all told 14 feet of 6" shelf under lights to accommodate 31 dishes, and 20 feet more above (with just window light) for 54 dishes. In all, 85 dishes for planted spores and gametophytes.

In the lower cases, there is about 14 square feet of soil space where row upon row of the "patches" of tiny ferns grow from glass-covered "babyhood" to uncovered "childhood" under the lights; and above, the upper shelves are 2" wider, offering about 16½ square feet for rows of larger ferns in their "youth."

At present, there is even more than the usual keen interest, as about twenty of the dishes are planted to two species each in the hope of finding Asplenium, Dryopteris or other hybrids which have rarely been found in their native habitats. In other dishes are spores from England and Europe and from New Zealand to be tested for hardiness if they reach maturity. In others, are some from California and others of known inability to survive here without a greenhouse, and always in some dishes are Eastern ferns, more of which are wanted for Fernwood planting. But never at one time, even with 85 dishes, is there room for all the kinds I would like to try.

It is not always easy to ease the ferns into the world of the out-of-doors. This is usually done by choosing the time weather-wise and planting them in rows in nursery beds or cold frames where they stay for the first winter. Here attention can easily be given to lath and cheesecloth shade and frequent watering at first and to winter cover later. If they survive this ordeal, limestone rock ferns can go into the steps and wall, crested and frilled English ferns and others not native to eastern woods can be added to those already planted.

My soil mixture is roughly the usual "⅓ leaf mould, ⅓ sand, ⅓ soil." If leaf mould is scarce, peat is substituted. Each ingredient is put through a ¼" mesh sieve, then well mixed. Some of this mixture, which has a "good feel" (if it doesn't add more leaf mould or peat) is then sifted through the fine mesh of an ordinary window screen. Both mixtures are then sterilized in roasting pans in the kitchen oven set at 350° for 2 or 3 hours. Quite a bit of water is added to each roaster in order to create steam in the oven. Meanwhile, the dishes are washed and sterilized in a hot water bath canner. The first time, I put the soil in the dishes and sterilized all at one time, but the water evaporated leaving the soil to harden on the sides of the dishes in an unsightly ring.

When the soil has cooled sufficiently, the finer mixture is spooned into the dishes, or used as the top layer in the cases where tiny patches will be planted. The coarser mixture is all right for the underlayer and for planting larger ferns.

A mistake of my first planting was in filling in the soil too near the top of the dish. As a result, there was no space for the prothallia and tiny ferns to grow under the glass cover. Very little soil is needed at this beginning stage, so now ¾ inch of space is left between soil and glass. It is gently tamped into a smooth flat surface with any flat-bottomed glass or tamper. If it seems too dry, some distilled water is added and the cover put on.

When all the dishes to be used are prepared, they are taken, one at a time, into another room for planting. Here only one envelope of one kind of spore is opened, a few spores are shaken or scraped with the back of a table knife onto a clean white paper, then put through the finest tea-strainer obtainable onto a second white paper and examined with a hand lens or magnifying glass to be sure the microscopic, round-appearing spores are really there. They are then planted by tapping the paper over the dish.

As each dish is planted, it is labeled with a small-lettered strip of paper, narrow enough so that Scotch tape will cover it on all sides to hold it securely on the dish and to protect it from water.

Depending on weather and temperature, these dishes need watering only every 10-20 days. The logic of "constant moisture" of clay pots standing in water is reasonable, but as pointed out, untidy. In order to have the neatness of the pyrex dishes, I preferred to gamble on the correct amount of moisture. Sometimes, due to my absence or the pressure of other duties, some have become too dry but seem to recover if caught in time. Although frequent advice is to keep them "very moist and humid," my experience and the advice from Ann Arbor is that to err on the dry side is much better than keeping them too wet.

At present, I am experimenting with several dishes. At planting time, a small roll of floral clay was put around the rim of the dish and the cover pressed tightly onto it. These dishes show bubbles of moisture on the cover each day. Others planted at the same time have been watered three times.

While in the dishes, the plants are watered with bottled distilled water; when first in the cases, with boiled water, and later, when they have reached the "uncovered" or "upstairs" stage, I feel they should be able to cope with water from the faucet.

In spite of oven sterilizations of the soil (which of course is not a laboratory sure-proof method), occasionally a dish shows spots of a grey mould. If detected quickly its rapid spread over the whole dish can sometimes be stopped by removing the affected spot and dropping a few drops of copper sulphate solution on the soil and edges. Even worse, but fortunately less common, are algae which quickly turn the lovely green to slimy black. In theory, with 85 dishes planted, loss of one or a few should not be cause for discouragement or sorrow, but in fact, it always seems to be the one most wanted, or most-rare, or one whose supply is exhausted which is affected.

For transplanting the little patches from the dishes, the tool I find to be perfectly adapted to the job is an apple corer. The sharp point is used to dig around and lift a small patch, the rounded back is used to press it into the soil and then is neatly withdrawn, the point is used to gently tamp bits of soil around the edge of the little circle of green and smooth out the row.

This planting in rows, all in the same container rather than in separate pots or pans, seemed at first to be taking a desperate chance. Fungus or pest trouble of one might cause destruction of all. But this has never happened. Fungus or moss is promptly removed as soon as noticed. Watering is a guess and a gamble, but the layer of crushed stone at the bottom assures good drainage, and with a little experience there seems to be little danger of overwatering. A hand sprayer which gives a fog-mist spray is used for watering: later a bulb sprinkler is used.

As the ferns grow, an occasional lift with a weaker than usual solution of Rapid Gro or other safe foliage fertilizer is used every 3 to 4 weeks.

At first, it was my intention to mark each row with small green plastic markers, but these were not practical. A list of names of each row in each section is made. These dated lists must be changed each time there is an exodus or entrance of new plantings, but the old lists are kept and form a good back-check when needed. The lists show the species planted, date of planting, source of the spores, the dates of the first germination, and first transplanting. They show, for instance, that spores having the 18 hours of artificial light per day germinate in 2 to 4 weeks, those planted at the same time having only window daylight take a week to a month longer. In one year one planting kept under lights saved 3 to 4 months growing time.

With considerable satisfaction I can look at my dish of promising prothallia and two rows of small size Asplenium pinnatifidum and remember the time a few years ago that I paid $2.50 for one small specimen just so I could see it—and later lose it.

Last fall, a friend from upper Michigan sent for identification a frond of the rare and recently discovered Hartstongue. It was loaded with spores. Now there is a whole crowded row of Hartstongue fronds about 2" tall.

There is a little patch of a very dwarf Adiantum pedatum found in the Olympic Mountains and not yet scientifically described. A purchased plant gave spores which when planted and grown proved to retain the dwarf size and to be hardy through our Michigan winters.

A rare back-cross hybrid appearing quite by accident in one of the rows last fall was discovered by Dr. Wagner, and will soon be described by him in the Journal. This gives rise to the hope for other planned hybrids. There are just two plants of a crested Asplenium trichomanes developed from sowing a bit of frond sent with many others by Mr. Rugg from England. But now there are several fronds heavy with sporangia which will assure future plantings.

And so I might go on to mention others as rare or as long-wanted. In the short space of time the spore exchange has been in existence, a creditable list of available kinds has been built up. Many friends, not even members of the Society or knowing one fern from another, send fronds "with brown dots" from near and far vacation trips. Officers and members of the Society have been generous with time and effort to make contributions, but in order to keep a supply of fresh spores and of a growing number of species on hand, this must be repeated year after year.

We ask the continued cooperation of all in sending the spores or fertile fronds to this exchange and also urge more members to request them in order to grow them and thus to duplicate in larger or smaller amount the pleasure I have derived from cooperation with nature in her mysterious and magic plan for the life cycle of a fern. ●

The Historical Depth Of Chemistry

• By **Arnold R. Beezer, S.J., B.A.,** *(Gonzaga University)*
SPOKANE, WASHINGTON

The neglect of the history of chemistry has deprived many students of an appreciation of the impact of chemistry on our culture, and has resulted in students acquiring a distorted picture of the nature of chemical theory and chemical research.

In view of the fact that extensive chemical theories and facts require so much of the student's time, can we justify the neglect of the historical background of chemistry?

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Not too long ago I heard a science lecturer pose the following question: "How many men at one time and without any knowledge of science and technical skill would it take to build an airplane?" "One, a hundred, or a thousand?" A fair answer to this question, I am sure, would be a number close to infinity.

If you transfer the question to modern developed chemistry, the answer remains the same. A large number of chemists in one period of time have not built the structure of modern chemistry; rather over the entire course of western civilization individual chemists or teams of chemists have added small bits of knowledge to chemistry and made it what it is today. The extension of our chemistry at present has depended and still depends on time.

In fact, as you know, the entire course of chemistry has extended from ancient Egypt to our modern world. The famous figures responsible for the theoretical and practical advances, and those who have spent their lives in chemistry are only a small total of the billions of human beings who have lived since the beginning of recorded time. What I wish to emphasize is that relatively few men over a long period of time and not huge numbers of men in one age have built the entire structure of chemistry in its present state.

The extension, i.e., the two dimensional breadth and width of modern chemistry is massive. Most topics in a freshman college text occupy large treatises of several volumes. Anyone who thumbs through *Chemical Abstracts* will readily agree that chemistry over the years has expanded in a geometrical progression.

But there is a third dimension, that of depth, which completes the picture. It is the time factor or the history of chemistry or whatever you may wish to call it. All who study chemistry come in contact with the history of chemistry. Some high school and college students receive a bit of chemical history at the beginning of a general chemistry course; less hear a word or two on some famous figure, such as Ostwald or Kekulé in an advanced college course; and other more fortunate undergraduate and graduate students formally study the history of chemistry, thus gaining an insight into the over-all depth-dimension of chemistry.

Here it would be well to ask a few questions. Assuming that we all possess an historical background to a greater or less extent, how valuable is it to the chemist? Is it only good for mere pastime, *Wissenschaft*, and so forth? Or does it enrich one's knowledge of chemistry? Does it help one see chemical knowledge as it really is, i.e., a body of ideas developing more and more in fertile minds? I could continue to ask question after question that has arisen in my mind, but I am afraid that they would follow *ad infinitum*, if I did not ask you to question yourself honestly on the depth value of history in your widely extended grasp of chemical knowledge.

It is generally admitted that the scientific progress of past ages, since the beginning of western civilization, is minimized in favor of the present body of chemical knowledge. Leonard K. Nash points out that, "To date science teaching has largely neglected, oversimplified, or willingly misread the rich legacy of scientific history. . . . The neglect of scientific history has resulted in the neglect of the material that is genuinely important to an understanding of science, and the misreading of history has fostered ideas about science that are sterile at best and misleading at worst."[1] The author of this statement goes on to point out some of the absurd "fables" that have been handed down as regards chemical discoveries of the past.

The sources of a warped and distorted view of the historical background of chemistry are complex. For example, take the small amount of chemical history inserted in the first few pages of a text book. In fact, just recently I thumbed through one of the better high school chemistry texts. With all due respect for the fine development of chemical principles in the book, I was surprised to see only seven out of seven hundred and fifty pages devoted to a brief synopsis of Egyptian, Grecian, alchemical, and modern history of chemistry. The seven pages in themselves are adequate as a summary, but they are isolated from the theoretical and practical matter of the text book. Throughout the book there are brief references to Lavoisier, Mendeleev, Boyle, and others; but these names are there only for the sake of crediting the discoverer for what modern chemistry embraces today. One chain of facts runs as follows: For several centuries the Greek philosophy of atomism was hidden; John Dalton, a teacher in England, published his atomic theory in 1808; the theory is etc. . . etc. . . Is this sufficient information for positing the atomic theory? What esential information is needed? What method of presentation of the facts should be employed?

Before I answer these questions and comment on the approach cited, allow me to refer back to the other types of historical chemistry that are offered, viz.,

"passing reference to an occasional historical figure" and "formal history of chemistry." The college chemistry major assimilates a vast amount of necessary facts and consequent theories. Occasionally there is a passing reference to the founder of a certain branch of chemistry. For example, William Henry Perkin, the discoverer of the first coal-tar dye, is suitable. The first question that comes to my mind is this: How does Perkin fit into the scheme of chemistry? This question implies that there are certain related discoveries and events preceding and following the discovery of the first coal-tar dye. The background of this discovery is interesting. Less than fifteen years after the isolation of aniline in coal-tar, before people believed in the tetrahedral carbon and in the first days of valence in our modern sense, when the Kinetic Theory of Gases was just being founded, Perkin synthesized the first aniline dye (mauve). This touched off studies of diazo compounds, fuchsine, methyl violet, aniline black, aniline yellow, alizarin, and indigo which culminated in the establishment of the coal-tar dye industry which the Germans controlled for seventy-five years. Perkin's discovery is not an isolated fact, but it is in an historical context.

Often throughout advanced courses brief remarks on various men of chemistry make up the historical depth of the student's knowledge. Perhaps this is an unavoidable situation in light of the fact that extensive chemical theories and facts require just about every moment of the student's time. Furthermore all will grant that the subject matter of the courses should receive priority. Yet in this situation where time is scarce, chemical history will hold the subject matter together if it is integrated properly. Rather than be an extra burden, chemical history weaved into the core matter of a course shows development of ideas and events within a particular branch of chemistry.

Courses in the History of Chemistry?

However in most schools, to supplement the historical deficiencies of the various chemistry courses, an elective course on the history of chemistry is offered, once the student has studied the major branches of modern chemistry. The number of chemistry majors who take this course will vary from school to school. I will agree that this is a good approach towards the problem of giving historical depth to the chemistry curriculum. However only a very small percentage of those who study chemistry, whether on the high school or college level, ever take advantage of a formal history of chemistry course. My concern is for the thousands of high school youngsters who study chemistry for a year, for the liberal arts students who fulfill their science requirement by taking freshman college chemistry, and for the hard working chemistry majors who exclusively concentrate on all the branches of chemistry. Are they going to have a "brief summary at the front of the book" or "passing reference to an occasional historical figure" type of chemical history?

Clara de Milt, writing in one journal, has provided me with a good starting point for answering the question. She says, "Every graduate student specializing in chemistry is first and foremost a human being, responsible to an extent determined by his talent and ability to partake in preserving western civilization. If he is an intelligent student he must inform himself in one way or another of the factors that have determined the development of this country and those like it, so that in the years to come he may exert his influence effectively to preserve what we think is valuable to us. It is my conviction that he can do this only by exercising his mind in thinking with the investigators and philosophers of the past, which means he must know something of the history and philosophy of science."[2]

This applies just as much to high school students and those in college as it does to graduates. The first and last part of the statement are fundamental. Human beings are studying chemistry which other men and women of the past have built through the past fifty centuries of western civilization. The practical Egyptians, the theoretical Greeks, and their successors in the history of chemistry were men and women like ourselves. They were endowed with the primary innate judgment that everyone experiences and which drives one to seek for knowledge. The ancient chemists and those of the Middle Ages sought to know the nature of the material world, even though they were more concerned with other branches of knowledge and practical applications of chemistry than with chemistry as we know it today—a science. As you know, the pioneers of chemistry moved ahead in scientific progress at a very slow rate in comparison with the last 175 years of modern chemistry. But this is only reasonable in light of all the human events that took place before 1775. Man's place in history today is characteristically scientific. Yet in earlier periods of western civilization the arts, philosophy, and theology claimed much of the time of men. To round out the story of 5000 years of recorded chemical and human events is beyond our scope here. However I wish to make it clear that men of all ages in some way have made chemistry what it is today. It is very easy to date the birth of chemistry from 1775 and consider the preceding years as only productive of occult and mystical theories, and opportunistic experimentation to make gold.

Fortunately however through the efforts of the historians of science such as George Sarton[3] and historians of chemistry a more healthy and intellectual outlook on the value of chemistry's past has developed. It aims at deepening the subject matter of chemistry. For example, note a typical preface to a general history of chemistry: "To trace the interrelationships of chemical concepts I have had to devote considerable attention to the earlier periods when chemistry was not recognized as a science in its own right. Many historians of chemistry, especially in earlier days, have felt that only after the time of Boyle and Lavoisier could chemistry have a real history. This does not seem to me to be true. The germ of many modern theories is to be found among the ancient Greeks or even earlier. Fortunately it is becoming possible to consider these early

years in more detail than could have been done some time ago."[4] I might add that over twenty years ago George Sarton was concerned with this problem of giving all periods of any science their due.[5]

When human beings study the chemistry developed by others in every period of the past, then will students respect the work of every chemist of the past and profit culturally. The long and continued efforts of many men and women alone brings chemical progress. All chemists from antiquity to today have had to exercise their intellects in patient experiment and involved formulation and testing of theories. The chemistry of all past ages is ours; we only have to encompass it for what it is worth.

At this point I would like to attempt to resolve the problem created by my previous questions. I have mentioned earlier two ways in which the history of chemistry is given to the majority of chemistry students. One group receives a few pages of history almost completely isolated from the main body of the chemical subject matter; the others hear a name of a famous chemist snatched out of the rich context of chemistry's history.

Teacher Versus Book

To provide a solution to the problem I must begin with the premise that a book is never a substitute for a good teacher. In other words, only as teachers can we make chemistry living. Even though a chemistry book may integrate large amounts of chemical history into the core matter of the course, still it is up to the good teacher to put across chemical history as integrated into the subject matter. One method by which this may be done and which I have found successful, is the logical, progressive approach—questions and answers—which leads to deeper knowledge. The acquisition of knowledge is progressive, i.e., a step by step procedure from what is more known to us to what is less known. For example, when we were young we may have thought that water was an element. Later in school we came to know that it was made up of two elements—hydrogen and oxygen. Slowly but surely we came to know more and more about these elements and so forth . . . By this method the unknown comes within a man's grasp.

The entire course of chemical history is very suitable to the logical, progressive approach. No doubt you have experienced its value and have incorporated the historical backgrounds of chemistry into your various courses. A good example of this approach is the way in which the four element theory is used. It is very easy to disregard this theory, ridicule it, and finally end the reference to it in a tone of disgust. Yet if you and your students were living 2300 years ago wouldn't it seem rather reasonable in light of the empirical evidence at hand? In historical context the four element theory is very reasonable and provides sufficient material for some mental gymnastics on a student's part at the beginning of a general chemistry course[6]. Just the right questions can bring some remarkable answers. At the same time it is well to point out that the general disdain for Aristotelian physics stems from a vital misunderstanding of the two principles of nature, viz., prime matter and substantial form, behind the four elements. These principles are not elements or things, but principles of activity or composition which in an element or thing make it to be such and such an element or thing. With a full understanding of the Grecian philosophies of nature a teacher may profitably incorporate the theories of the four elements and atomism into an early section of any general chemistry course. These theories offer any number of questions. For instance, why did the Greeks hold atomism? Why did they hold the four element theory? Were their reasons valid in both instances?

In some respects an advanced course is preferred to a method involving the logical, progressive approach. Take, for example, the famous "*berthollide-daltonide*" question. Certainly most compounds that we know today are "berthollides," viz., of variable composition. Yet strange to say, the law of definite composition which typifies "daltonides" has won the battle for the first place in the text books. Several factors which account for this from the early part of the nineteenth century, viz., the establishment of the law of definite proportions and so forth, make excellent matter for appropriate questions. Furthermore it is good to mention that the classical experiment on the preparation of iron sulfide is used to exemplify the law of definite proportions while actually iron sulfide typifies variable composition with a ratio of its constituents in the neighborhood of 11:10 as a minimum. Many other special topics with suitable questions present themselves for incorporation into an historical method of teaching chemistry.

Including essential chemical history in a course, also enables a student to grasp the scientific method of discovery—as a living method and not a set of dried up rules. Slowly but surely as the student resolves each problem with the giants of chemical history he comes to realize that, "A scientist knows *why* a certain procedure must be followed as well as what the procedure is. He knows how to set up the problem and to ask the kind of question that can be answered."[7] By logical development through chemical history the student integrates all the facts, laws, and theories in their real worth for the sake of the subject matter and not just for the sake of their own isolated values—whatever they possibly be worth in and of themselves. As a result there is a relation between the extensive subject matter and the historical dimension of depth which produces a complete and vital picture of chemistry—one of three related dimensions.

I am not going to attempt to outline a procedure for incorporating all the essentials of chemical history into the main subject matter of all the chemistry courses. The good teacher of chemistry has done or can do this with effort and ingenuity. I only wish to state the question, point a way towards resolving it, and show what can happen in the future to thousands of American youth who are taking various chemistry courses.

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The Argument From Authority

• By **Henry van Laer, D.Sc.,** *(University of Leyden)* ***and***
Henry J. Koren, C.S.Sp., S.T.D., *(Catholic University)*
DUQUESNE UNIVERSITY, PITTSBURGH, PENNSYLVANIA

The physical and biological sciences are founded on the concrete data of the senses. Sense data must be obtained by direct observation or by experimentation. However, lack of time and other considerations frequently demand that the scientist consult the literature in his field.

This is a condensation of a chapter in the authors' book THE PHILOSOPHY OF SCIENCE. *Father van Laer is at present Professor at the State University of Leyden in the Netherlands. Father Koren is chairman of the philosophy department of Duquesne University and editor of the Duquesne Studies, Philosophical Series.*

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No one is able to obtain all knowledge through personal research, whether it be for lack of time or ability. In the event that one cannot obtain information by personal research, the use of arguments from authority is not unreasonable and even perfectly rational, provided certain requirements are met.

Requirements of the Argument from Authority

For convenience sake we will call the one upon whose authority we must rely the *communicator*, and that which is accepted upon his authority the *communication*. To accept upon authority is also called *to believe*. In addition, we assume here that the original communication is made known to us without any intermediaries. To be rational, reliance upon authority with respect to direct communications requires that the following conditions be fulfilled.

1. It must be certain that the communicator has made the communication in question. This communication may have been given directly to us orally or in writing or be contained in a written document.

2. It must be certain that the communicator possessed the necessary knowledge and insight and that he did not make a mistake.

3. It must be certain that the communicator did not intend to deceive, i.e. his trustworthiness must be definitely established.

4. It must be certain that the interpretation one gives to the communication agrees with the intention of the communicator.

TRUTH REVEALED BY GOD. With respect to truths revealed by God, the second and third conditions are beyond discussion because they cannot be fulfilled. But it remains to be proved that God has really made the communication in question and also that our interpretation of it is correct. The first condition is concerned with the proof of a historical event. It has to be established by historico-critical methods and touches also the problem of intermediaries who transmit the communication. The question of interpretation is a problem of exegesis. Because of the special difficulties involved in our lack of insight into such truths, an authentic exegesis will often be necessary. For the definitive determination of revealed truths and their authentic interpretation we are referred to the teaching authority of the Church which Christ has founded for this purpose.

COMMUNICATIONS OF MAN. Any communication of man which is offered to us as to be accepted upon authority must satisfy the four requirements.

Regarding the *first requirement*, as a rule, there will be little difficulty if the communication in question is of a recent date. In the case of communications made in the distant past, there may be special difficulties, which have to be solved through a historical investigation.

With respect to the *second requirement*, a distinction is necessary. If there is question of the simple observation of a fact or event, it has to be certain that the communicator was capable of observing it. If, on the other hand, the matter concerned was a scientific statement, for which perhaps a long and complex experimental investigation was required or difficult theoretical speculations, then it must be definitely established that the communicator possessed the required intellectual capacities and other necessary means. In general, it will be possible to accept, without objection, communications if one is convinced that the communicator is an "authority" with respect to the subject in question. Nevertheless, one must always take into account the possibility that human communicators are subject to errors because of insufficient keenness of sense powers or intellectual capacity and sometimes also because of influences coming from man's emotional life. Such influences often result in an unconscious one-sidedness of view and the overlooking of difficulties. In cultural sciences one's view of life or general philosophic position will often lead to an incorrect interpretation of the facts.

Concerning the *third requirement*, in general, it may be presupposed that there is no intention to deceive. Nevertheless, because of human frailty deliberate deception is a distinct possibility which cannot be wholly excluded. Historic cases of intentional fraud teach us to be on guard in this respect. It is possible, for instance, that a defender of a theory, especially in a polemic exchange of views, through vanity or in order not to admit error, will deliberately twist the facts to make them fit the theory. Incidents of this kind have

occurred in the past. Accordingly, it is imperative to be on guard against it in discussions.

The danger of deliberate deception is especially great in the cultural sciences, specifically in history, in which so much depends upon the personal interpretation of the author. The last few decades have witnessed large-scale falsification of history in certain totalitarian States, where the ruling powers decided what youth had to be taught concerning history. Occasionally, even physical sciences have become the victims of this method.

With reference to the *fourth requirement*, often it will not be easy to satisfy it, especially if the communicator himself has not clearly stated his meaning. In such a case recourse must be had to other means, which, however, often do not allow more than a probable opinion. Here, too, there is great danger that the interpretation will be guided too much by one's personal views and desires, so that often much will simply be put into the communicator's mouth. Difficulties of interpretation will occur especially with great frequency in the realm of the cultural sciences.

Communications Through Intermediaries

If the communication has not been laid down in writing by the communicator himself or has not been directly spoken to us by him, we will be dependent upon intermediaries who received the communication and transmitted it to us either orally or in writing. Such intermediaries must satisfy certain requirements, which practically coincide with those of the communicator.

1. It must be certain that the intermediary transmits the communication upon the authority of the original communicator.

2. The intermediary does not need to have an insight into the communication, but it must be certain that he knows the original communication and that he did not err in transmitting it.

3. It must be certain that the intermediary did not deliberately falsify the communication.

4. The interpretation of the communication given by the intermediary is irrelevant unless it expresses the proper interpretation of the original communication.

These demands would seem to be clear enough without any further comment. If they are met, we do not rely upon the authority of the intermediary but upon that of the original communicator, i.e. in the case of divine Revelation transmitted through intermediaries, upon the authority of God; and in the case of human communications, that of man.

Regarding the case of divine Revelation, it will be necessary to show by historico-critical means that the above demands are met. In this case, these intermediaries will be mainly the authors of the New Testament. The required argumentation is usually set forth in that part of dogmatic theology which is called "*praeambula Fidei.*" It is beyond our scope to enter into this question.

Value of the Argument from Authority

The so-called argument from authority is not a proof and as such does not result in an insight. As soon as in one way or another an insight is acquired, the truth in question will be accepted because of this insight and no longer upon authority.

With respect to divine Authority (Scripture and Tradition), the revealed communication in its right interpretation is true beyond doubt and absolutely certain; hence it is able to serve as the indisputable starting point of the supernatural science of theology. Divine Authority often is the only possible way to arrive at certainty in theological matters.

Regarding human authority, if the requirements are met, the communications in question will supply a valuable contribution to natural science — "natural" being taken here in opposition to "supernatural." In general, however, one may say that such communications do not have more authority than their original source. Hence the scientific authority of the communicator must always be taken into consideration.

Moreover, in difficult problems, such as those of philosophy, the possibility of error cannot be discounted, not even with respect to the most expert communicator. Accordingly, in human sciences the so-called argument from authority is the lowest and weakest of all because it lacks the strength of inner evidence. Nevertheless, it would be foolish to reject absolutely all authority and everything that has come down from the past through tradition, as was done by Francis Bacon and Descartes, and to accept only that which can be acquired through personal insight.

On the other hand, there are also cases on record in which authority has been too firmly adhered to and its utterances accepted without discrimination. Examples of such an unlimited reverence for authority were found among the Pythagorians, who wanted to cut short every discussion with a simple "*Ipse dixit*," (the Master has said it); also among many Aristotelians, especially in the Middle Ages, who did not dare to accept anything which went against the view of Aristotle, "The Philosopher." The reproach of such a slavish following of Aristotle is often addressed to Albert the Great and Thomas Aquinas, but unjustly so. Both resist precisely the uncritical acceptance of Aristotle's sayings. "Aristotle is no God but a fallible man," said Albert. Thomas often quotes the opinions of Aristotle and other authoritive authors, both pagan and Christian, but he uses them only, after serious examination, as a confirmation or illustration of his own view. He is not influenced by misplaced reverence. "Harmony, which is an effect of charity, consists in a union of hearts and not of views." He never considers authority as the criterion of scientific certainty. Authoritive communications are quoted by him as the opinions of others and distinguished from true philosophical arguments.

As a general rule, it is good to make use of the results achieved by our great predecessors and to give them a

(Continued on Page 65)

Genesis I:1-31

• **By Joseph P. Moroney, C.S.Sp., D.Sc.** *(Villanova University)*
COLLEGE OF LIBERAL ARTS AND SCIENCES, DUQUESNE UNIVERSITY

The misinterpretation of Holy Scripture has been a big factor in the science-religion controversy.

If we wish to determine the meaning of an article or an amendment of the Constitution of the United States, we must look into its history, investigate the intention of the Congress in adopting it, and study the decisions of the Supreme Court in interpreting it. The Bible, like the Constitution, cannot be interpreted by a study of the text alone, but it must be studied against the background of its history, original language, and tradition.

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Difficulties in reconciling the account of creation in Genesis and the theory of evolution are the result of a misinterpretation of the Scriptures or a misunderstanding of the theory of evolution. We will attempt to determine the content and meaning of the first chapter of Genesis and to show that it is in no way contradictory to the scientific theory of evolution.

As a basis for our discussion, we will assume the following:

1. The fact of revelation by means of Holy Scripture and Tradition.
2. The inspiration of Holy Scripture.
3. The Church is the official custodian and interpreter of the Bible.
4. That our assumptions can be proved by the methods of apologetics.

There are certain fundamental considerations which we must bear in mind in interpreting the Bible. They are:

1. We must never abstract from inspiration in arriving at a decision.
2. We must remember that the Bible is not a modern book. We must keep in mind *the genius of the Hebrews*, and their methods of writing history and poetry.
3. We must also try to discover the purpose of the inspired writer. For example, did he intend to write history in the strict sense of the word, or did he intend to write a work containing historical details?
4. Not only must the immediate context be studied, but also the whole context of the book in question.

The order of creation and the geological time table seem to be the chief sources of difficulty. Even before the advent of modern science, the order of creation caused many problems, for example, the creation of light prior to the creation of the sun. In the Third Century A.D., Origen wrote:

> "What rational creature would be prepared to believe there was a first, second, and third day, morning and evening, before the sun was made?" (De Principiis IV.3)[1]

In considering this account of creation, we must realize that it is not God's purpose to teach us the facts of science, and that the primary purpose of revelation is to teach us the things we must know in order to serve Him and to save our souls. There are three possible views that can be considered as a basis for the interpretation of this chapter:[2]

I. *Strictly Literal View*
According to this view, each word is taken in its strictly literal sense. One day would be a period of twenty-four hours.

II. *Concordistic Views*
Some try to harmonize the strictly literal view with the scientific theory of evolution. This can be accomplished by taking the word "day" to mean an era or an indefinite period of time. Others have suggested that after the fall, the race of men dispersed and a backward evolution took place and *homo sapiens* evolved to the earlier forms of primitive man. However, it seems that concordistic views create as many problems as they solve.

III. *Idealistic Views*
Here we can distinguish extremist and conservative views.

1. *Extremist Views*
Under this heading we can group such views as the dream theory, which states that the first chapter of Genesis is a dream of Moses. Other theories claim that God revealed these things to Moses in a series of visions, or that the account is a ritual hymn. There is no real foundation for any of these hypotheses. Lastly, the narrative of Genesis is called a myth—this is to be rejected as an outright denial of inspiration.

2. *The Conservative View*
At present the simplest solution of all difficulties is to see in these chapters a history of the world's origin told in metaphorical form. This view enables us to maintain the literal sense and to avoid the difficulties which result from attempts to treat the narrative as strict history in the formal sense of the word.

In support of the conservative view, we have the internal evidence of the text, tradition, the fact that it is in harmony with the principles of interpretation laid down in the Encyclical *Providentissimus Deus* and the decisions of the Biblical Commission, and lastly, it conforms to the principles outlined in the Encyclical *Humani Generis*.

Evidence of the Text

If we examine the first chapter of Genesis, we note the following:

1. Creation consists of a series of definite operations.
2. The style is poetic.
3. The account is essentially anthropomorphic. God is depicted as a man—He acts, plans, and speaks as a man.
4. The account is expressed in popular language and according to appearances, e.g., the sky is described as a vault above the earth.

In view of the above characteristics of the account, it would seem that Moses, the inspired author, did not intend to present a description of the actual process of creation, but merely to teach that *God created all things.*

Papal Documents

In the Encyclical *Providentissimus Deus*, Pope Leo XIII quotes the rule of St. Augustine for the interpretation of Scripture when it seems that it comes into conflict with scientific theories:[3]

> "Whatever they can really demonstrate to be true of physical nature, we must show to be capable of reconciliation with our Scriptures; and whatever they assert in their treatises which is contrary to these Scriptures of ours, that is, to Catholic faith, we must either prove it as well as we can to be entirely false, or at all events, we must without the smallest hesitation believe it to be so."

In 1909 the Biblical Commission in a series of decisions laid down the following principles:[4]

1. The first three chapters of Genesis contain a narrative of things which really happened, and the narrative corresponds to objective reality and historic truth.
2. We must maintain: The creation of all things by God in the beginning of time, the special creation of man, the formation of the first woman from man, the unity of the human race, the original justice of man, the fall of man, and the promise of a Redeemer.
3. Where there is lack of agreement among the Fathers and Doctors of the Church, we are free to follow and defend a prudent opinion.
4. We need not follow the strictly literal sense.
5. We do not need to seek *scientific* exactitude in the text.
6. The word YOM, the Hebrew word for day, may be taken as a period of time.

In 1906 in considering the Mosaic authorship of the Pentateuch, the Biblical Commission stated:[5]

> "It may be granted without prejudice to the Mosaic authenticity of the Pentateuch, that Moses employed sources in the production of his work, i.e., written documents or oral traditions, from which to suit his special purpose, and under the influence of *divine inspiration*, he selected some things and inserted them in his work, either literally or in substance summarized or amplified."

If we grant such a possibility, we must of necessity admit that the account of creation is not strictly literal.

Tradition

In the interpretation of Scripture, we must also bear in mind that there is another source of revealed truth, namely, tradition, and in the consideration of the meaning of any text, we must take into account the traditional interpretation of the text.

In the *Summa Theologica*, St. Thomas discusses the creation of the world in six days.[6] In his discussion, St. Thomas favors the more literal interpretations of the text, but he does not rule out the conservative view. He cites the opinions of the Fathers and Doctors of the Church, and as a result of these citations, we have in this section of the Summa a convenient digest of the teaching of the Fathers and Doctors of the Church. As for example, in Question Seventy-one of the Pars Prima, in discussing the creation of animals:

> "But at the first beginning of the world, the active principle was the word of God, which produced animals from material elements either in act, as some holy writers say, or virtually as Augustine teaches. Not as though the power possessed by the water or the earth of producing animals resides in the earth and water themselves, as Avicena held, but in the power originally given to the elements of producing them from elemental matter by the power of the seed or the influence of the stars."

In various places in the discussion, St. Thomas points out that the majority of the Fathers consider the various phases of Creation to indicate different periods of time, but that Augustine and others are of the opinion that Moses, because he had to instruct an uneducated people, divided up what really took place all together. In Question Sixty-eight, St. Thomas lays down a very sensible rule:

> "In discussing questions of this kind, two rules are to be observed, as Augustine teaches. The first is to hold to the truth of Scripture without wavering. The second is that when Holy Scripture can be explained in a multiplicity of senses, one should adhere to a particular explanation, only in such a measure as to be ready to abandon it if it be proved with certainty to be false, lest Holy Scripture be exposed to the ridicule of the unbelievers, and obstacles be placed to their believing."

Humani Generis

In August 1950, Pope Pius XII published the Encyclical *Humani Generis* in which the theory of evolution is discussed. It is the first papal document to mention the theory of evolution by name. It discusses the need of revelation, calls attention to some of the abuses of the theory of evolution, and cautions against a too liberal interpretation of the Book of Genesis. However, in this encyclical, there is an implicit admission of the validity of the conservative view in this statement:

> "Whatever of popular narrations have been inserted into the Sacred Scriptures must in no way be considered on a par with myths or other such things, which are more the product of an extravagant imagination than that of striving for truth."

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Science Is As Science Does

• **By Robert T. Hance, Ph.D.**
DEPARTMENT OF BIOLOGY, OUR LADY OF CINCINNATI COLLEGE, CINCINNATI, OHIO

Is the shortage of humanists as critical as the shortage of scientists?

Many believe that humanists and scientists must cooperate to prevent the destruction of our culture by the misuse of science.

You will find the author's views on science and the humanities challenging.

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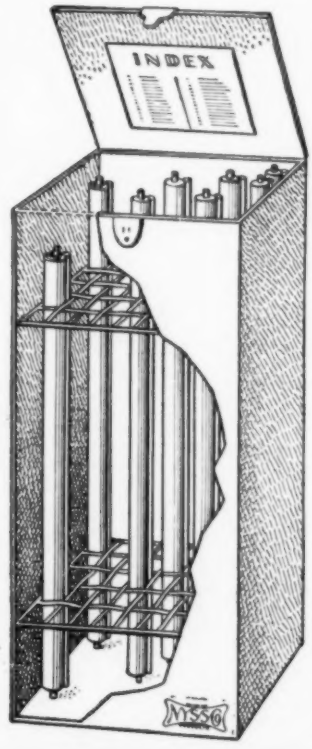
Science, fortunate in being concerned with tangible things, is more comprehensible to the average person than are many other just as worth-while but less definite fields of culture. The utilitarian value of the products of science naturally tend to make us forget that science is, after all, only a part of the sum of human activities. The whole of any subject is a composite of parts and the man trained in the facts of one field alone is seldom a cultured or rounded person. He is a technician who handles the mechanisms of his small body of details but can rarely put them together into useful generalizations. The real scientist knows his facts as they bear upon many others and can talk with any man. In the last analysis science is straight thinking and differs from other fields of intellectual activity in the materials worked with rather than in methods of thinking about them.

The originality or imagination called for in the planning of a scientific experiment and in the synthesis of the results into a working hypothesis is certainly no greater and but very little different from that required in the creation of a literary or musical composition. Lord Bryce once wrote that science advances through its ability of calling *many* things by the *same* name or, in other words, in the recognition of features or principles common to several groups. Certainly the humanities serve helpfully by calling the *same* thing by *many* names thereby spotlighting the variability and spiritual phases of the universe.

That workers in demonstrable things originally spotlighted straight thinking is probably beyond question but the growing feeling that they should be, or are today, the sole guardians of objective reasoning seems silly. Perhaps in many instances the students of the humanities have failed in "organizing common sense"



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but this has always seemed to me to represent failure of individual training rather than basic differences in the requirements of the subject matter.

Let then those who are to teach of the facts of the universe be well trained not only in the sciences but be also and equally well disciplined in the relation of these facts to the whole of culture. Straight thinking would seem to be the common denominator in the search for truth whether it be in Sanskrit, in Biology or in putting the atom to work. ●

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Genesis 1:1-:31

(Continued from Page 58)

Also, the possibility of the evolution of man's body may be held, but *polygenesis* is ruled out. It is difficult to see how such ideas can be held without using the Conservative View in interpreting Genesis.

The Conservative View establishes a very broad principle of exegesis. It is in harmony with the context of Genesis, the decisions of the Biblical Commission, the encyclicals of Leo XIII, Pius XI, and Pius XII, and it is supported by the authority of many of the Fathers and Doctors of the Church. So far as the *scientific* theory of evolution is concerned, it offers no difficulty, and while some may favor a more literal interpretation, they should not rule out the possibility of the Conservative View.

Lastly, in all questions concerning science and religion, we must keep in mind the teaching of the Church that there can be no conflict of faith and reason. A necessary corollary of this teaching is that there can be no real conflict of science and religion, for the God of revelation and the God of nature are the same. ●

REFERENCES

1. Origen De Principiis, Quoted in Alexander Jones, UNLESS SOME MAN SHOW ME, page 70, Sheed and Ward, (1951).
2. Hugh Pope, O.P., Catholic Students' Aids to The Bible, p. 198, Second Edition, R. and T. Washbourne, London, (1918).
3. ROME AND THE STUDY OF SCRIPTURE, Abbey Press, St. Meinrad, Indiana, page 22, (1943).
4. *Ibid.* pp. 84-86.
5. *Ibid.* p. 80.
6. Summa Theologica, *Pars Prima*, Questions 66 to 75, English Dominicans' Translation.

THE SKY IS THE LIMIT

The fiction of Jules Verne is rapidly becoming fact as the world begins to adapt to a new "space age." Satellites are now in orbit. Sending a rocket to the moon is under active discussion. Outer space travel is sufficiently close for the conducting of military experiments to simulate its conditions.
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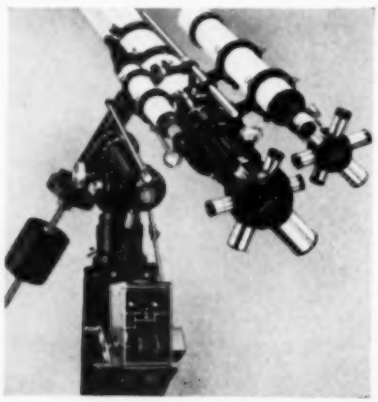

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The Historical Depth

(Continued from Page 54)

The solution to the problem is not in any book, but in the heads of expert chemistry teachers.

James B. Conant wisely says, "The history of science demonstrates beyond a doubt that the really revolutionary and significant advances come not from empiricism, but from new theories. The development of these theories, in turn, has in the past depended on free discussion of their consequences."[8] Just as the history of philosophy is the laboratory of the philosopher where he observes the parentage, environment, development, and function of ideas, so the history of chemistry becomes a special kind of laboratory where the chemist discovers the evolution and development of chemical ideas. A methodology, drawing on the historical depth of chemistry, enables young minds to penetrate more deeply into the ideas of chemistry and, in turn, into its relation to all the other activities of a chemist's life. ●

LITERATURE CITED

1. Nash, Leonard K., J. Chem. Educ., **28**, 147 (1951).
2. de Milt, Clara, J. Chem, Educ., **29**, 343-344 (1952).
3. Sarton, George, "A History of Science," Harvard University Press, Cambridge, 1952, pp. vii-xv.
4. Leicester, Henry M., "The Historical Background of Chemistry," John Wiley & Sons, New York, 1956, p. 6.
5. Sarton, George, "The Study of the History of Science," Dover Publications, Inc., New York, 1957, pp. 20-26.
6. Crombie, A. C., "Augustine to Galileo," Harvard University Press, Cambridge, 1953, pp. 44-51.
7. Klubertanz, S. J., George, P., J. Chem. Educ., **32**, 248 (1955).
8. Conant, James B., "Modern Science and Modern Man," Doubleday & Company, Inc., Garden City, New York, 1953, p. 53.

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This history of surgery was prepared for publication in 1939, but due to the outbreak of World War II, it was not published. The author has added a postscript of thirty-one pages summarizing the developments from 1939 to 1956. It is a very interesting and comprehensive history of surgery.

As Doctor Graham's story unfolds, we view the evidence of superstitious trepanning of Neolithic man and the mixture of magic and surgery that existed in very ancient times. Greek and Roman contributions to the development of surgery and later developments in the art of surgery are discussed, as are some of the honest misconceptions and quacks which hindered its growth. We meet such interesting characters as the barber surgeon and the corpse thief. The contributions of such men as Hippocrates, Galen, Lister, Pasteur, and others are well treated.

This book is not only a history of one phase of medical science, but it is also a real contribution to the literature of the development of modern science.

J. P. M.

Photo by Vic Kelley

The Scientific Study of Social Behavior

• *By* MICHAEL ARGYLE. Philosophical Library. New York. 1957. Pp. 239. $6.00.

Those who are seriously interested in the scientific study of social relations will agree that Argyle has produced a minor classic. In the first part of the book the author gives an excellent account of modern scientific developments in the area of social research, cutting across the fields of Sociology and Psychology. He eliminates the treatment of personality and socialization (the processes by which the individual is helped to take on the social and cultural characteristics of his group). Particular emphasis is placed on methodologies, procedures and techniques. Empirical findings are identified, summarized, and compared. Without adopting any particular theoretical position, the author explores the principal research designs, theories and generalizations, and the instruments by which they were derived.

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This book should find its way into the personal library of every one in the area of social studies at the College level.

Francis R. Duffy, C.S.Sp., Ph.D.
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The Story of Archaeology

• *By* AGNES ALLEN. Philosophical Library, Inc. New York. 1958. Pp. 245. $4.75.

This is the kind of popular book that only an expert can write. It presents a very clear account of the development, methods, and some of the principal discoveries of archaeology.

The introductory chapter explains how cities of the past have been buried and discusses the basic principles of archaeological science. The remaining chapters of the book are arranged in order of the development of archaeology. The various sites are discussed, and the histories of the people who once occupied them are briefly outlined. The author avoids excessive detail in the historical narratives and as a result, this book will not overwhelm the beginner.

We recommend "Why Must Archaeologists Dig?" to all who are seeking a good book to start studying archaeology on their own. *J. P. M.*

Earth, Moon and Planets

• *By* FRED L. WHIPPLE. Grosset and Dunlap. New York. 1958. Pp. IX + 293. $2.95.

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• *By* A. HYATT VERRILL. Grosset and Dunlap. New York. 1957. Pp. XII + 255. $1.98.

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Argument From Authority

(Continued from Page 56)

respectful but also critical reception. In matters where we ourselves through our own research cannot arrive at certainty, the authority of others who are better qualified offers support and provides a basis for a probable opinion or even certainty if all required conditions are perfectly fulfilled.

In our own era of specialization, in which it has become impossible for one man to arrive at something even remotely resembling the personal mastery of all sciences, appeals to the authority of others are often made far too easily. Without any critique, adherence is frequently given to whatever may be found in encyclopedias, textbooks and popular scientific works. Moreover, there is a strong tendency to accept as true and certain all utterances of a great man of science, even when they refer to questions outside the realm of his specialization; e.g. when a capable physicist speaks about philosophy or religion. In this matter, it will be well to keep in mind the warning given by Husserl:

> When it is really physical science which speaks, we will gladly listen and as respectfully as juniors. But it is not always physical science which speaks when physicists speak, and certainly *not* when they speak about "Philosophy of Nature" and "The Scientific Theory of Knowledge."[1] •

[1] *Ideen zu einer reinen Phaenomenologie und phaenomenologischen Philosophie*, Halle, 3rd ed., 1928, vol. I, p. 38; also *Husserliana*, vol. III, The Hague, 1950, p. 46.

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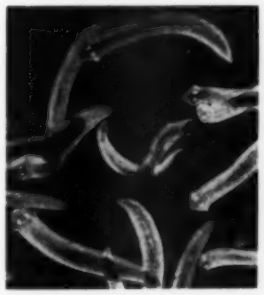

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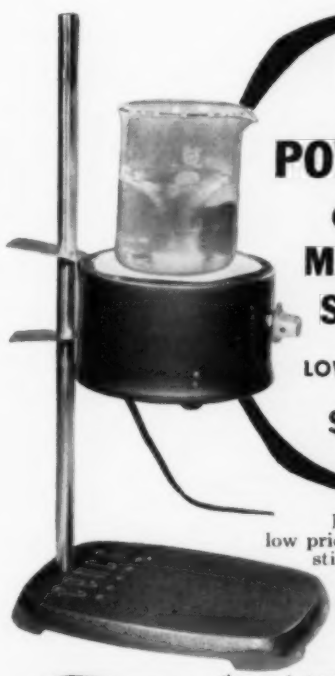

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Martian Atmosphere

(Continued from Page 48)

is because the light from Mars passes twice through its atmosphere—once coming from the sun and once after reflection from the Martian surface.

The spectrograph used in the present investigation could detect no H_2O bands beyond the one at 0.823 microns (1 micron = 10,000 Å). However, theoretical analyses by E. K. Plyler and W. S. Benedict[4] of the Bureau's radiometry laboratory, and others, indicates that the bands at 0.942, 1.135, and 1.379 microns are more intense. As shown in Table I, the band at 0.942 is about 3 times, the one at 1.135 about 10 times, and the one at 1.379 at least 60 times more sensitive than the band at 0.823. C. C. Kiess was able to detect the bands at 0.942 and 1.135 microns in the laboratory, where a strong source of artificial light was available[5].

Nonetheless if water vapor is to be detected in the relatively weak light from Mars by means of the longer-wavelength bands, more efficient detectors than the present types of photographic plates are needed. Increased sensitivity could also be obtained from balloon-, rocket-, and artificial satellite-based spectrographs. Excellent results have already been obtained in this way on the spectrum of the sun, revealing hitherto undetected portions in the infrared as well as in the ultraviolet. ●

TABLE I.

Absorption bands of H_2O in the red and infrared portions of the spectrum. The second column gives, for each band, the associated quantum numbers for the 3 fundamental modes of vibration (stretching, bending, and distortion) of the H_2O molecule. The relative transition probabilities are a measure of the intrinsic intensity of the absorption lines.

Wavelength of Band Head (u)	Vibrations ν_1, ν_2, ν_3	Relative Transition Probability
1.379	(1, 0, 1)	>6
1.135	(1, 1, 1)	1.000
0.942	(2, 0, 1)	0.3
0.823	(2, 1, 1)	0.1
0.723	(3, 0, 1)	0.03
0.652	(3, 1, 1)	0.005

REFERENCES

1. For further technical details, see High-dispersion spectra of Mars, by C. C. Kiess, C. H. Corliss, Harriet K. Kiess, and Edith L. R. Corliss, Astrophysical J. **126**, 579 (November 1957.)
2. Mauna Loa observatory for high-altitude research, NBS Tech. News Bul. **40**, 137 (October 1956).
3. The B band of oxygen in the spectrum of Mars, by W. S. Adams and T. Dunham, Jr., Astrophysical J. **79**, 308 (1934); Some results with the coudè spectograph of the Mount Wilson Observatory, by W. S. Adams and T. Dunham, Jr., Astrophysical J. **93**, 16 (1941).
4. Private communication from E. K. Plyler and W. S. Benedict (1956).
5. Wavelengths of rotational lines in the water-vapor bands at 0.93 and 1.13 microns, by C. C. Kiess, J. Research NBS **48**, 377 (1952), RP2325.

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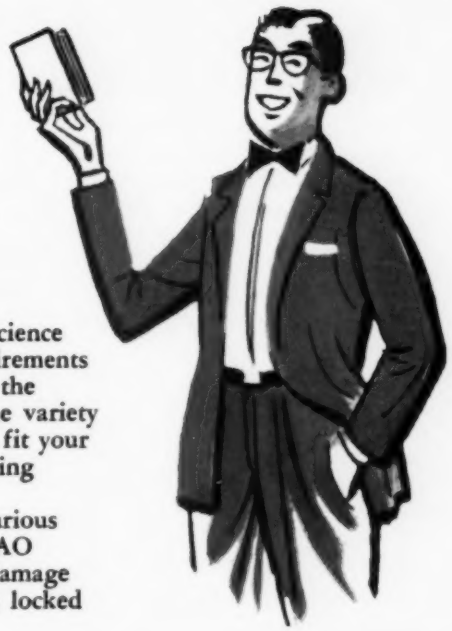

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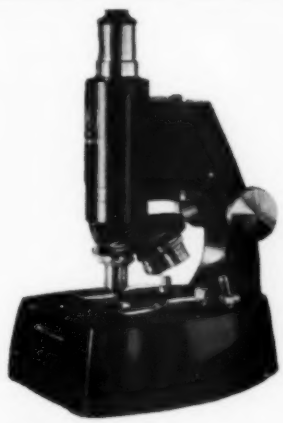

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In a basic sense, the campaign hinges on a habit. The female generally does her hunting indoors, pausing for rest on a wall before and after biting. Walls of dwellings sprayed with DDT will kill her on contact, and retain enough of the insecticide six months later to kill shortly after contact.

So the malaria fighters are tackling the gigantic eradication job literally house to house. Houses in malarial regions have been scheduled for at least three annual sprayings. This way, doctors believe they can break the parasite's cycle—mosquito to man and back again. The disease can only be transmitted from one human to another by the parasite-carrying Anopheles. The parasitic cycle is completed when a noninfected mosquito picks up the parasite by biting a victim who has already contracted malaria.

With the annual sprayings, the mosquitoes should be prevented from starting any new infections, and old ones will tend to burn out since the parasite loses its reproductive ability after a few years. Where DDT is ineffective, dieldrin, another insecticide, will be used.

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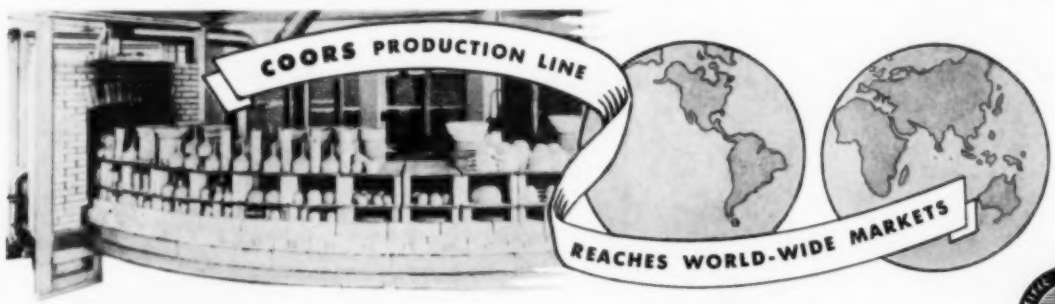

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Foreign Technical Information Center

Secretary of Commerce Sinclair Weeks announced new measures to increase scientific knowledge through establishment of a Foreign Technical Information Center within the Department of Commerce.

To finance prompt action on the new project, the Department is requesting a special appropriation of $300,000 (contained in the supplemental request transmitted to the Congress by the President to initiate the program). In addition, the President's budget for 1959 includes $1,250,000 for the Department's Foreign Technical Information program.

The new program will set up a central clearinghouse in the Commerce Department's Office of Technical Services, headed by John C. Green. The Center is to collect, evaluate and distribute valuable foreign scientific and technical literature for the use of American scientists and engineers.

"In recent years, government agencies and private institutions and industries have steadily increased their translation of Soviet magazines, monographs and books," said Secretary Weeks. "At the present time, however, there is no central agency in the Government responsible for acting as a clearinghouse on all such foreign, technological, scientific and engineering information for the purpose of making it generally available to American scientists, research institutions and the public.

"With the cooperation of the National Science Foundation, comprehensive surveys were undertaken by the Department and other federal agencies last year, and the proposed new Center is the result of this groundwork. Plans have been worked out for public distribution of information from such organizations as the National Science Foundation, Atomic Energy Commission, the armed services and the intelligence agencies."

Arrangements have been made to obtain from these and other agencies copies of abstracts and translations of foreign technical articles, monographs and books. It is estimated that these will be supplied at an annual rate of 50,000 abstracts and 10,000 complete translations.

The items will be catalogued in the library of the Office of Technical Services. It is planned that the abstracts will be published and released to the technical press, and that copies of translations will be made available to the public.

A staff of engineer-translators will be added to review and analyze foreign publications and select those of greatest value. It is planned to appoint a scientific advisory committee to assist in the selection. Arrangements will be made for full translations of important articles and studies. Among the materials the engineer-translators will receive are copies of 200 important Russian scientific journals.

The new Center will operate a coordination service to eliminate duplication of translating among U. S. public and private agencies and by friendly foreign governments. In its own translation work, the Center will concentrate on technology.

The cooperation of industry, universities, libraries and commercial translation firms will be sought in feeding information to the Center.

The Office of Technical Services in recent years has been collecting and publishing reports of U. S. Government-sponsored technical research, including abstracts and translations of certain foreign documents. Its library contains many German research papers captured by the Allies. At present, between 600 and 700 new and non-classified reports of Government research are released through OTS each month, and those having widest interest are reprinted and sold at the cost of printing and handling.

Among regular OTS publications are a monthly catalog of Government research reports, catalogs on specialized subjects, and a newsletter reviewing new research of interest to small business.

The OTS also will continue studies and surveys of additional measures which might be taken to strengthen the collection and dissemination of both national and foreign technical information.

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Foundation Invites Proposals for Summer Institutes

The National Science Foundation announced recently that proposals and requests for funds are now being accepted for the support of 1959 Summer Institutes for the supplementary training of high school and college science and mathematics teachers. Universities and colleges which wish to sponsor such institutes are invited to request information from the Program Director for Summer Institutes, National Science Foundation, Washington 25, D. C. Deadline for the submission of proposals in final form is August 1, 1958.

A total of 125 institutes are scheduled for the summer of 1958 in 47 states, the District of Columbia, Alaska, Hawaii, and Puerto Rico. Increasing Congressional support of the program makes it desirable for the Foundation to plan now to triple the number of institutes to be held during the summer of 1959. Specifically designed by the Foundation to encourage a national policy to improve subject-matter mastery of science and mathematics teachers, institutes are planned and conducted by colleges and universities and commonly last from six to ten weeks.

Foundation support enables sponsoring institutions to pay stipends to participating teachers, plus allowances for dependents and travel, and contributes toward operational costs. The number of teachers varies from institute to institute, but averages about 50. *Teachers submit applications directly to the sponsoring institution, NOT to the Foundation.*

The Summer Institute Program has grown rapidly under National Science Foundation sponsorship since the first two were held in 1953. Approximately 6,200 teachers, mostly in the high school, will receive stipends during the present summer. More than 40,000 applications from teachers were received by sponsoring institutions this year. Total cost of the program in 1958 will be about $6,800,000.

The number of institutes for high school and junior high school teachers will probably exceed 300 in the summer of 1959. About 10 per cent of the 160,000 science and mathematics teachers in secondary schools of the country will be able to participate. It is expected that approximately 40 institutes can also be provided for some 1,800 college teachers, to whom only eight institutes are available this year.

Institutes represent only one of the Foundation programs directed toward improving the teaching of science and mathematics. Information concerning other Foundation programs for improving science education in the United States can be obtained from the National Science Foundation, Washington 25, D. C. ●

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THE CAMBOSCO GENATRON serves not only for classical experiments in static electricity, but also for new and dramatic demonstrations that are not performable by any other means. It exemplifies a modern method of building up the tremendously high voltages required for atomic fission, for nuclear research, and for radiation therapy.

Entirely self-exciting, the GENATRON cracks into action at the snap of the switch —whose only function is that of starting the motor drive. No auxiliary charging method is employed. Hence, despite an output measured in hundreds of thousands of volts, no hazard is involved, for the operator or for the observers.

An Output of 250,000 Volts — or More!

THE CAMBOSCO GENATRON is designed to deliver, in normal operation, a discharge of the order of 250,000 volts. That figure, a conservative rating, is based on many trials conducted under average conditions. With ideal conditions, a potential difference of 400,000 volts has been achieved.

Modern Design— Sturdy construction and ever-dependable performance distinguish the GENATRON from all electrostatic devices hitherto available for demonstration work in Physics. This powerful, high-potential source, reflecting the benefits of extensive experience in electrostatic engineering, has absolutely nothing but purpose in common with the old fashioned static machine.

NO FRAGILE PARTS—Durability was a prime consideration in the design of the GENATRON which, with the exception of insulating members, is constructed entirely of metal.

The only part subject to deterioration is the charge-carrying belt, which is readily replaceable.

NO TRANSFER BODIES—In all conventional influence machines, whether of Holtz or Wimshurst type, electrical charges are collected and conveyed (from rotating plates to electrodes) by a system of "transfer bodies." Such bodies have always taken the form of metal brushes, rods, button disk or segments—each of which, inevitably, permits leakage of the very charge it is intended to carry, and thereby sharply limits the maximum output voltage.

It is a distinguishing difference of the GENATRON that electrical charges, conveyed by a non-metallic material, are established **directly upon the discharge terminal.** The attainable voltage accordingly depends only upon the geometry of that terminal and the dielectric strength of the medium by which it is surrounded.

Unique Features of the CamboscO Genatron

DISCHARGE TERMINAL Charges accumulate on, and discharge takes place from, the outer surface of a polished metal "sphere"—or, more accurately, an oblate spheroid.

The upper hemisphere is flattened at the pole to afford a horizontal support for such static accessories as must be insulated from ground. A built-in jack, at the center of that horizontal area, accepts a standard banana plug. Connections may thus be made to accessories located at a distance from the GENATRON.

CHARGE-CARRYING BELT To the terminal, charges are conveyed by an endless band of pure, live latex—a CamboscO development which has none of the shortcomings inherent in a belt with an overlap joint.

DISCHARGE BALL High voltage demonstrations often require a "spark gap" whose width can be varied without immobilizing either of the operator's hands.

That problem is ingeniously solved in the GENATRON, by mounting the discharge ball on a flexible shaft, which maintains any shape into which it is bent. Thus the discharge ball may be positioned at any desired distance (over a sixteen-inch range) from the discharge terminal.

BASE...AND DRIVING MECHANISM Stability is assured by the massive, cast metal base—where deep sockets are provided for the flexible shaft which carries the discharge ball, and for the lucite cylinder which supports, and insulates, the discharge terminal.

The flat, top surface of the base, (electrically speaking), represents the ground plane. Actual connection to ground is made through a conveniently located Jack-in-Head Binding Post. The base of the Genatron encloses, and electrically shields, the entire driving mechanism.

PRINCIPAL DIMENSIONS The overall height of the GENATRON is 31 in. Diameters of Discharge Ball and Terminal are, respectively, 3 in. and 10 in. The base measures 5¼ x 7 x 14 in.

GENATRON, With Motor Drive

Operates on 110-volt A.C. or 110-volt D.C. Includes: Discharge Terminal, Lucite Insulating Cylinder, Latex Charge-Carrying Belt, Discharge Ball with Flexible Shaft, Accessory and Ground Jacks, Cast Metal Base with built-in Motor Drive, Connecting Cord, Plug, Switch, and Operating Instructions.

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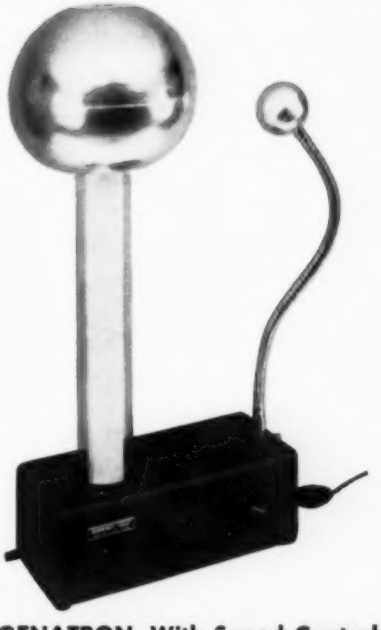

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Includes (in addition to equipment itemized above under No. 61-705) a built-in Rheostat, to facilitate demonstrations requiring less than the maximum output.

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